Model tests to investigate smooth water speeds of amphibious scout car, QMC-4. (Interim Report No. 1 [for the period] August 8 to September 23 [1941.] Roderick Stephens, Jr. Sparkman & Stephens, Inc. September 24, 1941.

9/24/41

RESTRICTED

Q.M.C. 4
INTERIM REPORT NO.1

8-8-41 TO 9-23-41

RESTRICTED

Q.M.C. 4

INTERIM REPORT NO. I

August 8 to Sept. 23, inclusive
of
MODEL TESTS TO INVESTIGATE SMOOTH WATER SPEEDS OF AMPHIBIOUS SCOUT CAR

for

THE NATIONAL RESEARCH DEFENSE COMMITTEE

Tests conducted in the Experimental Towing Tank of the Stevens Institute of Technology, Hoboken, New Jersey

Report by
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I N T R O D U C T I O N

This report covers the development of a model body which can be used on the present U.S. Army quarter-ton 4 X 4 scout car chassis.

S U M M A R Y

Tests conducted thus far indicate the feasibility of obtaining water speeds of between 7 and 8 m.p.h. utilizing present Willis quarter-ton 4 X 4 chassis fitted with watertight body which has same basic road clearance, the same width and height, and somewhat greater overall length. The weight empty would be increased from 600 to 1200# over the standard vehicle, depending upon construction details.

D E S C R I P T I O N

A scow type body has been designed giving the maximum of flotation with minimum overall dimensions. This has a trunk for each of the four wheels and a "T" trunk fore and aft for drive shaft and axles. Stuffing boxes are at each end of the transmission.

The standard wheel base, width and height has been maintained while the length and shape of forward and after ends and wheel cutouts were explored in successive towing tank tests, as described below.

At the same time tests were conducted investigating the possibilities of external portable floats, which we assumed to be less convenient but desirable if they afforded materially better speeds. These tests disclosed no improvement with power available (see page 9), so further float tests were discontinued.

F U R T H E R D E V E L O P M E N T

Hydrofoils are being investigated, though the preliminary calculations are not particularly encouraging. Hydrofoils may provide the most reasonable means of getting really good speeds without increasing basic dimensions.

In addition, a model with greater wheel base and greater overall length will be developed to see what additional speed the attendant sacrifice in roadability could provide.

D E T A I L E D D E S C R I P T I O N

It is planned to construct the body of light welded steel, fitting it to the standard chassis, from which all possible unnecessary parts and weight have been removed, and Special provision will be made to secure satisfactory brake operation after water transit, also to eliminate condensation in the axles and other submerged parts. The

radiator and fan will be redesigned. The cooling air will be supplied from inside the car body, as this would be the only place that would be reasonably dry under various conditions of water transit. The cooling air will exhaust through the side of the car at the top about midships fore and aft.

The additional body weight will be compensated for by special shock absorbers, which will be controllable so that the wheels can be retracted if desirable to increase water speed on long trips. At the same time wheels can be extended to increase clearance and give better traction when entering and leaving the water, or at other times of difficult land transit.

The body will have to have hinged coamings, which will serve to increase freeboard and eliminate harmful effects of water getting in the body in choppy weather.

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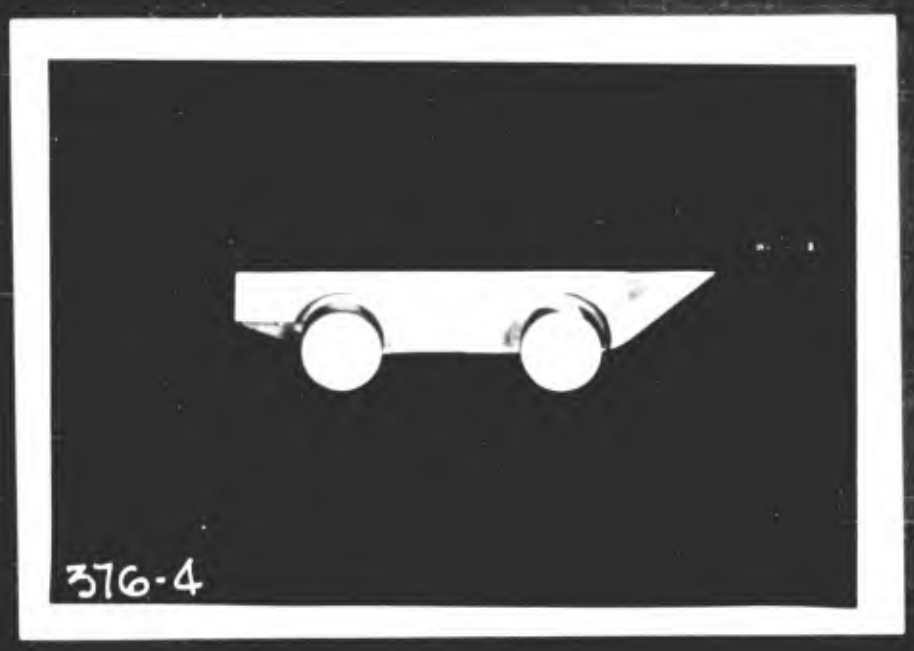
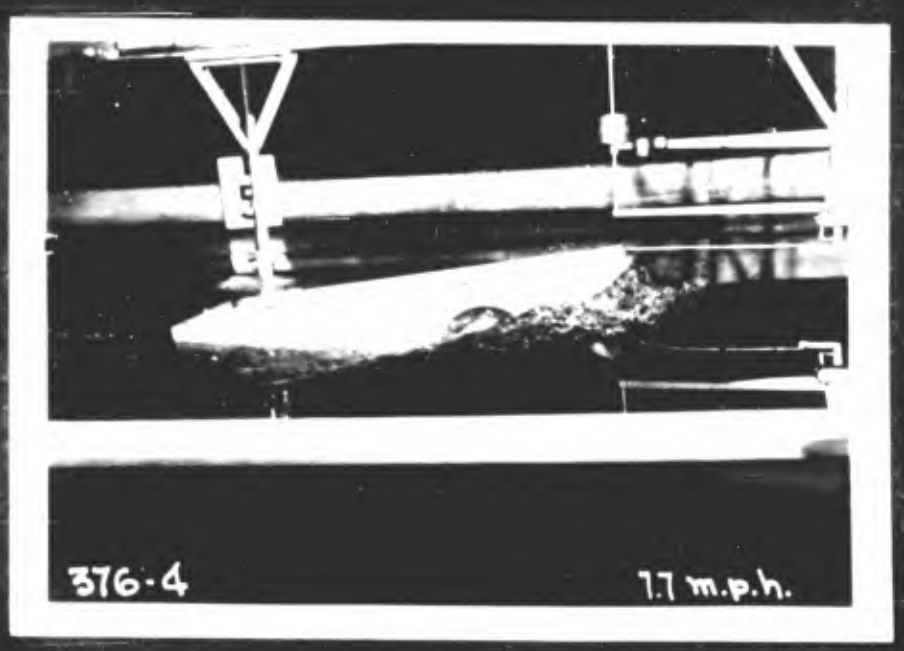




Best model to date - see pp. 7 & 10

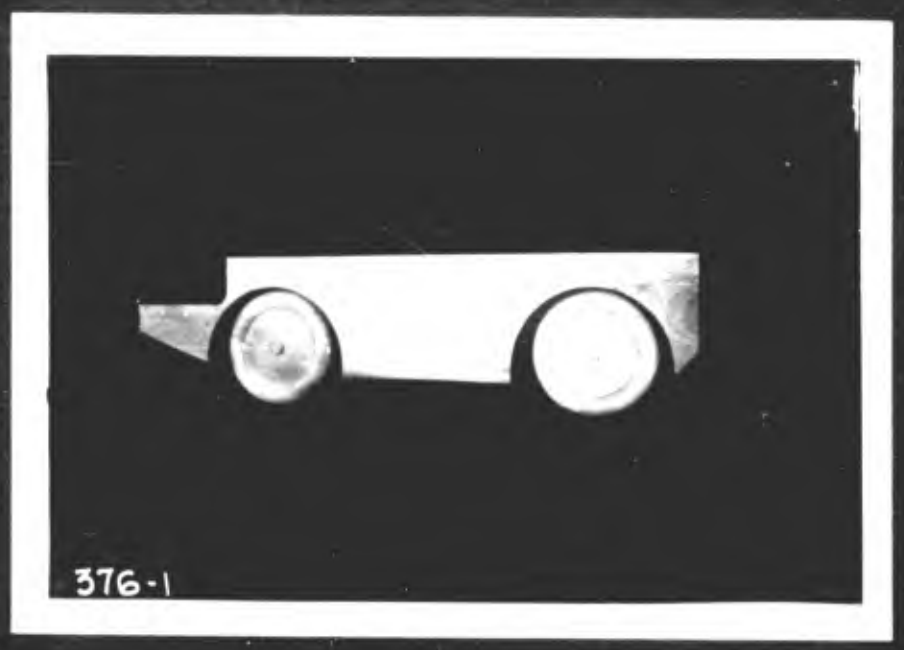
DETAILED REPORT

of

MODEL TANK TESTS

Note that 800# pay load is included in all weight figures. Also, resistance of breaks, springs, shock absorbers, steering rods, etc. has been allowed for in an estimated roughness allowance. However, this could only be estimated due to the unusual nature of these appendages.

Test #1 Aug. 8 Model S. & S. #402 - S.I.T. 376-1



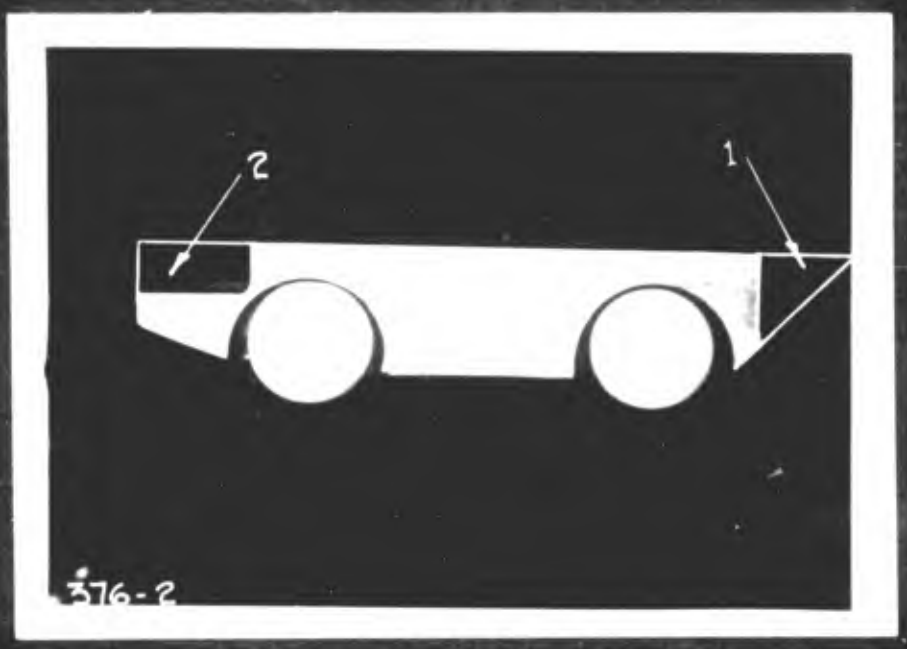
Conditions: 2800# - 4.42 to 5.52 M.P.H.

Results: See Experimental Towing Tank calc. I - 8/13/41

Comments: Resistance favorable but wave action of bow would not permit speed above 5.52 M.P.H. without excess water on deck.

Test #2
Aug. 11

Model S.I.T. #376-2



Alterations: 1. Bow extended - to improve bow wave.

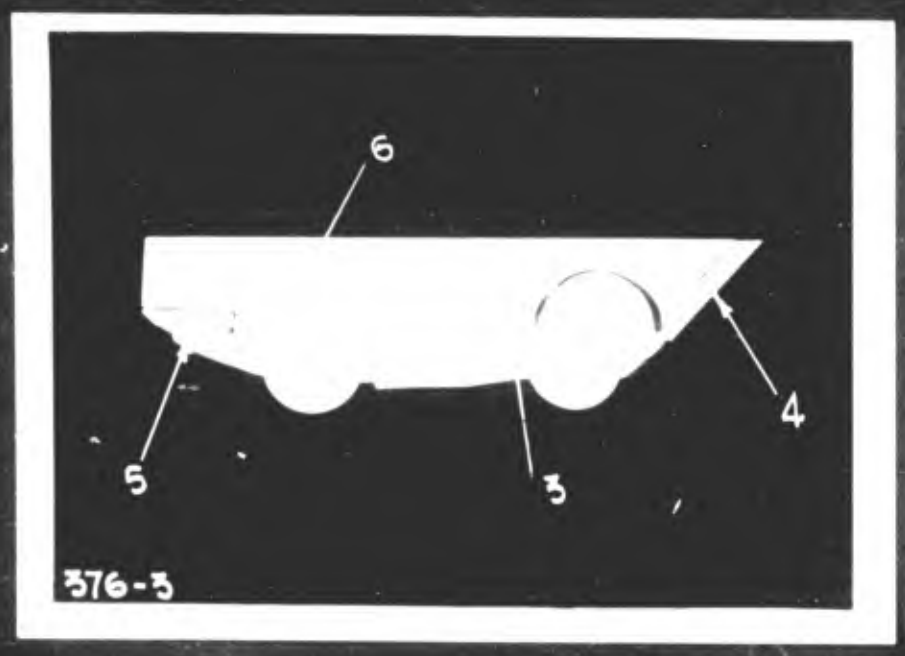
2. Stern freeboard raised to permit testing at 3400# and 4000#, which displacement seemed advisable in view of more detailed weight analysis.

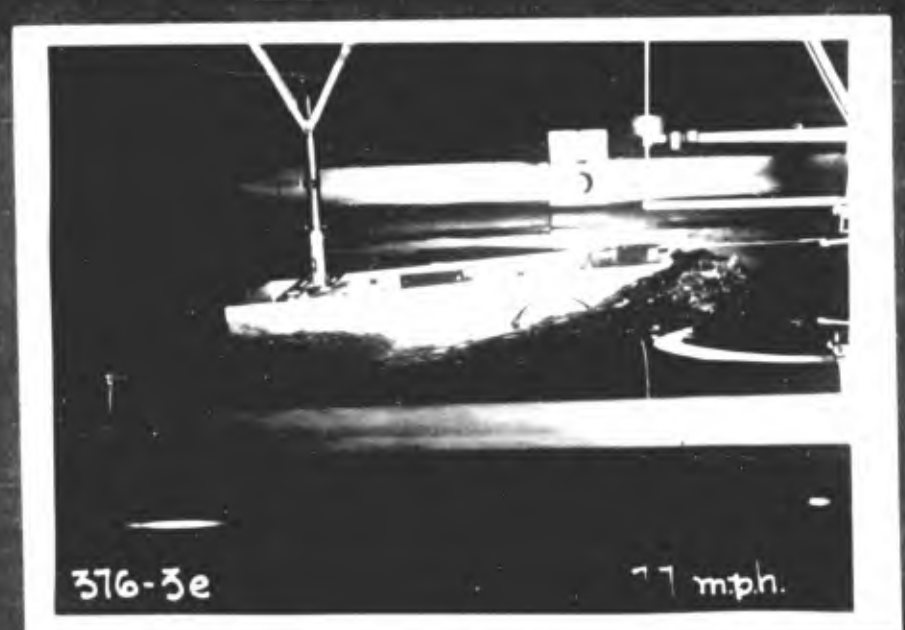
Conditions: 3400# and 4000# - 4.42 to 8.78 M.P.H.
Alterations 1 and 2 were both included throughout Test #2.

Results: See Experimental Towing Tank Calc. II - 9/18/41
(17.2 E.H.P. at 7.7 M.P.H. and 4000# disp.)

Comments: Alteration 1 produced improved bow action. Increased displacement not particularly detrimental and increased freeboard at alteration 2 probably has little effect as surface of water is still close to original cut down line.

Test #3 Model S.I.T. 376-3
Aug. 18





Alterations: 3. Diagonal cutout behind front wheels.

4. 45° chamfer of fwd. corners.

5. Cutout behind rear wheel openings.

6. Cover plate over rear wheel opening as altered by 5.

Conditions: 4000# - 6.6 to 8.78 M.P.H.

Alterations 3, 4, 5 & 6 were independently tested in 5 parts - a, b, c, d and e.

Results:

a. Model similar to 376 - 2 with alteration 3 cut out. This necessitated an <u>increase</u> of approx. .4 E.H.P. at 7.7 M.P.H.

b. Model as a above with alteration 4 cut out. This was an improvement on a (above) of approx. .7 E.H.P. M.P.H.

c. Model as b above with alteration 5 cut out. This was an improvement over b (above) of approx. 1.1 E.H.P. at 7.7 M.P.H.

d. Model as c above with alteration 6 added. This was ar improvement over b (above) of approx. .5 E.H.P. at 7.7 M.P.H.

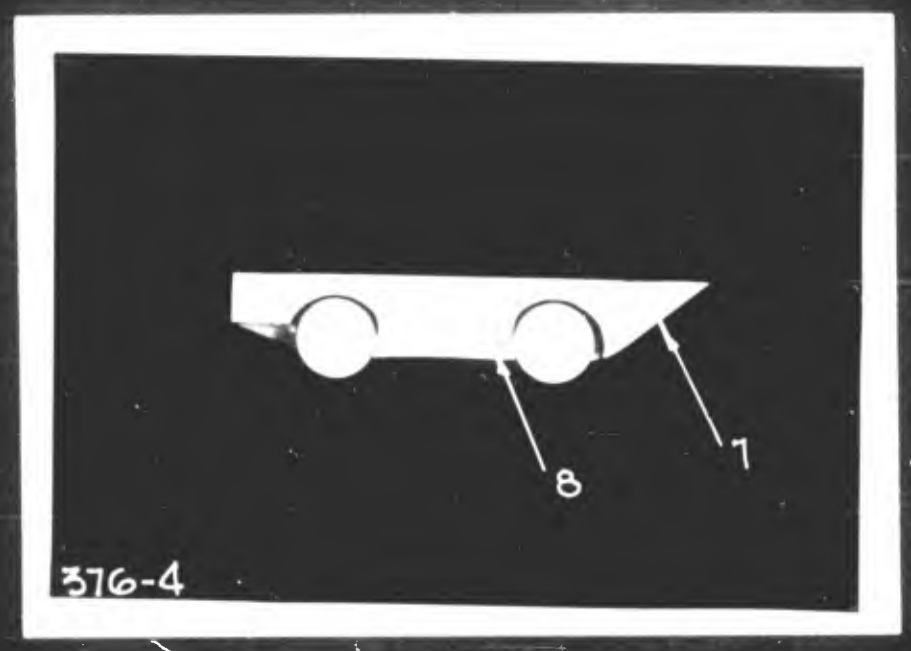
e. Model as d (above) with alteration 3 replaced (eliminating diag. cut out). This confirmed a (above) showing an improvement of approx. .3 E.H.P. on d (above) which bought result to 15 E.H.P. for 7.7 M.P.H.

See Experimental Towing Tank calc. III dated 9/18

Test #3
Cont'd

Comments: Bow wave action seemed still a large factor which might be improved. Also, better cutouts behind front wheels were indicated.

Test #4 Model S.I.T. 376 - 4
Aug. 22



Alterations: 7. Bow profile dropped to 37-1/2° (Alt. 4 chamfer retained)

8. New cutout behind front wheels.

Conditions: 4000# - 7.156 to 8.783 M.P.H.

Results: a. Model as in Test 3-e with addition of alterations 7 and 8 with an improvement of approx. 1.4 E.H.P. which brought result to 13.6 E.H.P. for 7.7 M.P.H.

b. Piece removed in alteration 8 was replaced, which increased by .5 over a (above) the necessary E.H.P. for 7.7 M.P.H.

See Experimental Towing Tank calc. IV dated 9/18

Comments: This model looks good in its water action and as resistance is also favorable it is recommended to build first full scale model to these lines.

Test #5 Aug. 25 Model S.I.T. 376 - 5

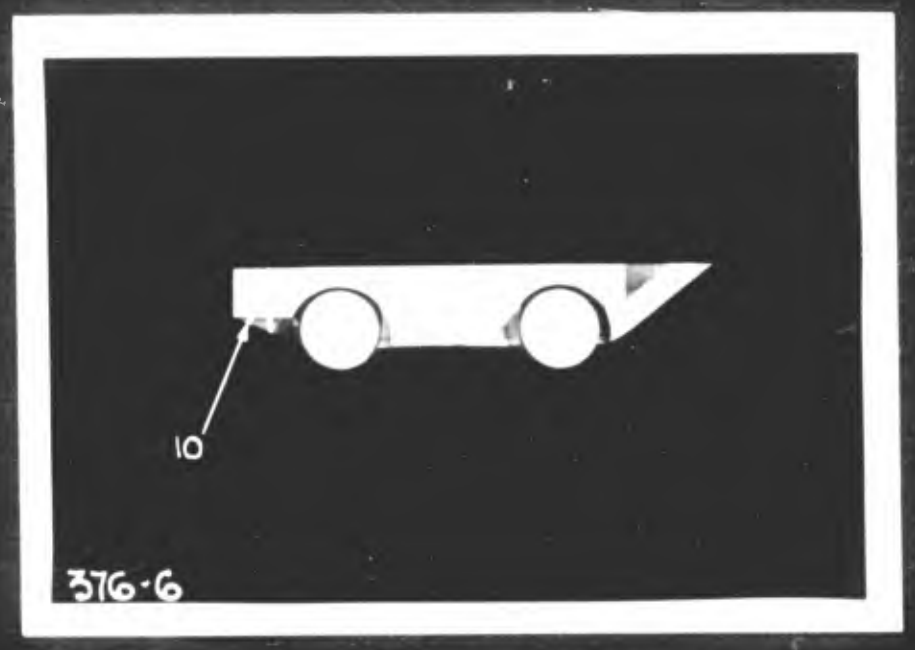
Alteration: 9. Rounding bow corners.

Result : Increase 1.2 the necessary E.H.P. for 7.7 M.P.H.

See Experimental Towing Tank calc. V, dated 9/18

Comments: Model was changed back to bow as in alt. 7.

Test #6 Aug. 28 Model S.I.T. 376 - 6



Alteration: 10. Shortening stern equivalent to approx. 12" in full scale car.

Conditions: 4000# - 7.7 M.P.H.

Results: Increase 3.5 the necessary E.H.P. for 7.7 M.P.H.

See Experimental Towing Tank calc. VI, dated 9/18

Comments: Length can not be saved at either end without valuable loss in water efficiency.

Test #7 Model S.T.T 376 B-1
Aug. 28

S. & S. 402 - 2 A floats mounted 3" away from sides of car. Top of float 30" below top of car and front of float 8-3/4" fwd. of original (test #1) front of car.

Conditions: 4000# at 7.7 M.P.H.

Results: Increase by 3.9 the necessary E.H.P. for 7.7 M.P.H.

See Experimental Towing Tank calc. VII, dated 9/18

Comments: Floats tend to bury fwd. It appears that floats must be lengthened to get favorable resistance characteristics.

Test #8 Model S.I.T. 376 C-1
Sept. 9

S. & S. 402 - 2 B floats mounted 3" away from car sides, 30" below car deck and fore & aft as per S. & S. Dwg. 402 - 2 B

Conditions: 3400# at 7.7 M.P.M. all wheels lowered and 3400# at 7.7 and 9.9 M.P.H. with front wheels raised.

Results: Floats run better and resistance approaches best car.

See Experimental Towing Tank calc. VIII, dated 9/15

Comments: Floats good enough in water to justify modest alteration and further test over wider range.

Test #9 Model S.I.T. 376 C-2
Sept. 13

Alterations: After waterlines slightly eased and 2.5 radius along chines. Floats mounted flush with sides of car and 30" below deck and all wheels raised. Longitudinal location as in test 8.

Conditions: 3400# and 4000# from 6.6 to 11 M.P.H.

Results: Resistance above car up to power considered available (60 B.H.P. - 20 E.H.P.) its resistance more favorable above 24 E.H.P.

See Towing Tank calc. IX, dated 9/15

Comments: Above results not good enough to justify floats which are very large and cumbersome. Float tests discontinued.

Test #10 Model S.I.T. 376 - 4, exactly as in Test #4
Sept. 16 & 17

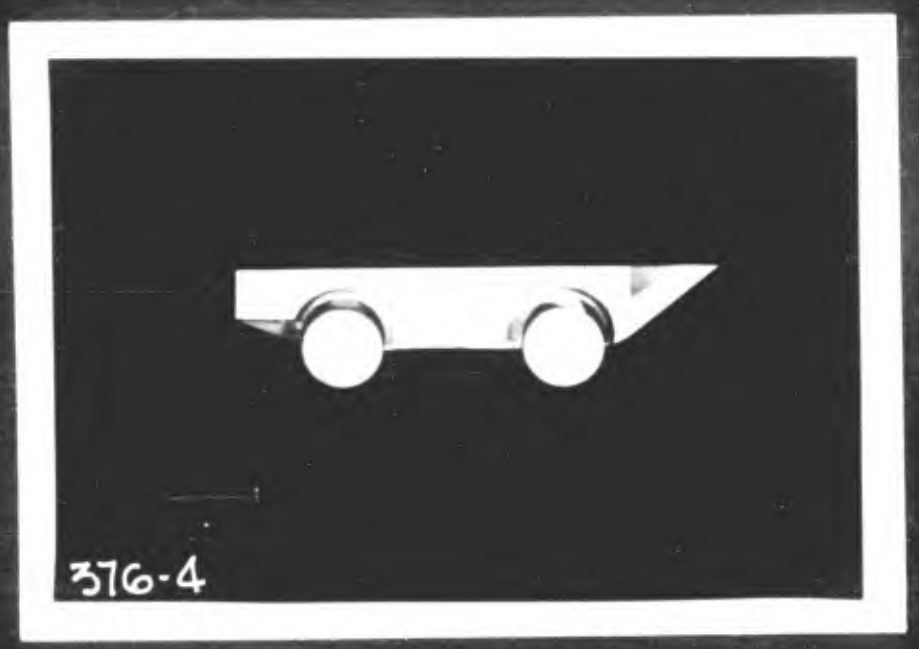
Conditions: 3400# and 4000# from 6.6 to 9.9 M.P.H.
3700# from 7.2 to 8.2 M.P.H.

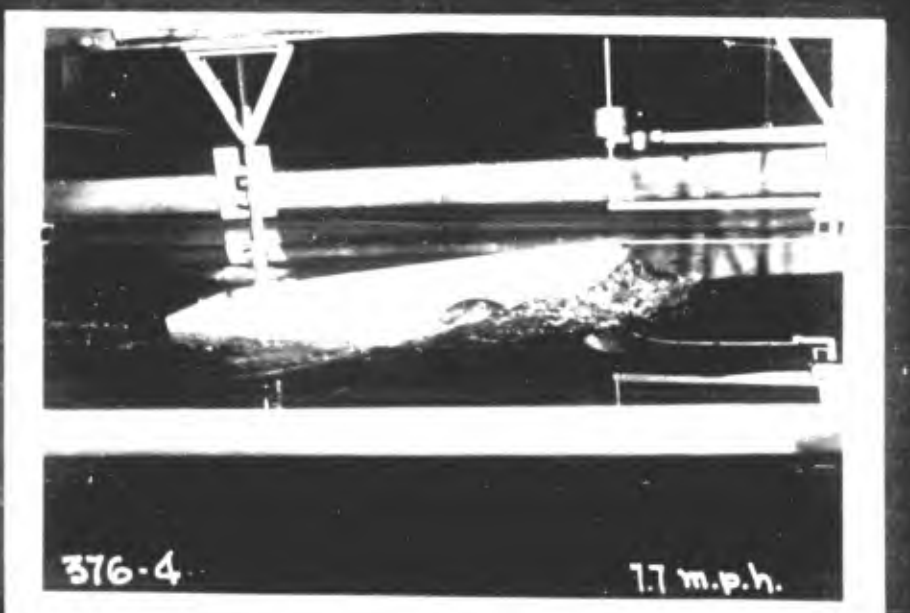
Results: Checks both results and conclusions of Test #4. Also at 3700#, which is probably close to final weight, 8.2 M.P.H. indicated for 19.3 E.H.P.

See Towing Tank calc. X, dated 9/18

Comments: These characteristics seem sufficiently satisfactory to justify immediate construction of full scale working model.

Test #10-a Model S.I.T. 376 - 4, as in Test #4 (and Test #10)





Alterations: All wheels in free hanging (lowered position.

Conditions: 3400# and 4000#, 6.6 to 9.9 M.P.H.

Results: Effect of lowering wheels negligible at 7.7 M.P.H., 4000#, lowering wheels increased E.H.P. from 13.6 to 14.3 - or at 13.6 E.H.P. speed is reduced approx. .1 M.P.H.

See Towing Tank calc. Xa, dated 9/18

Comments: Tire tread, differentials, steering & break connections all could contribute to wheels making more difference on full scale model. Ability to force wheels down has obvious desirability on entering & leaving water and other times of heavy going so two way controllable hydraulic shock absorbers would seem still desirable.

Test #11 Model S.I.T. 876 - 4 c
Sept. 20

Alteration. Part of stern behind rear wheel cut outs altered in shape in an effort to better resistance.

Condition: 4000# 7.2 to 8.2 M.P.H.

Results: Resistance slightly increased.

See Towing Tank calc. XI, dated 9/22

Comments: Alteration discarded as it also sacrifices necessary displacement aft.

GENERAL CONCLUSIONS FROM SCALE MODEL TESTS

The displacement length ratio is such as to make it difficult to get much speed without materially increasing dimensions or materially decreasing weight. Further testing of the present Model (376-4) will undoubtedly uncover additional refinements which might add perhaps 1/2 M.P.H. at top speed. It is planned to continue these tests in conjunction with development of the longer wheel base model and any worthwhile advantages which are encountered in sufficient time will be included in the full scale model No. 1.

EXPERIMENTAL TOWING TANK
Stevens Institute of Technology
Hoboken, New Jersey

Sparkman & Stephens

August 13, 1941

AMPHIBIAN SCOUT CAR

376-1

Δ_s - 2,800 lbs.

G_L - 3.84 feet aft of front axle

SPEED NO.		SPEED M.p.h.	RESISTANCE	E.H.P.
H_1	2	4.42	172.	2.03
	3	4.97	253.	3.35
	4	5.52	362.	5.33

NOTE: Model swamps at speeds higher than 5.52 M.p.h.

Roughness addition - 0.400×10^{-3}.

#402

(13)

CALCULATION 1

9/24/41

EXPERIMENTAL TOWING TANK
Stevens Institute of Technology
Hoboken, New Jersey

Sparkman & Stephens, Inc.

September 13, 1941
(Replaces Calc. II report
of August 13)

AMPHIBIAN SCOUT CAR

376-2*

Δ_S = 4,000 lbs.

G_L - 4.08 feet aft of front axle

SPEED NO.		SPEED M.p.h.	RESISTANCE	E H P
H_1	2	4.42	183.1	2.2
	3	4.97	263.2	3.5
	4	5.52	366.5	5.4
	5	6.07	442.4	7.2
	6	6.61	510.0	9.0
	7	7.16	650.6	12.4
	8	7.70	838.6	17.2
	9	8.24	1057.0	23.2
	10	8.78	1299.0	30.4

Δ_S - 3,400 lbs.

G_L - 3.96 feet aft of front axle

2	4.42	161.5	1.9
4	5.52	335.4	4.9
6	6.61	485.0	8.5
8	7.70	808.6	16.6
10	8.78	1228.0	28.8

Roughness addition - 0.400×10^{-3}.

*Bow extended at a 45° line from existing bumper up to line of deck.
Stern extension brought up vertically to deck line.

EXPERIMENTAL TOWING TANK
Stevens Institute of Technology
Hoboken, New Jersey

Sparkman & Stephens, Inc.

September 18, 1941
(Replaces Calc. III reports
of August 18 and 20)

AMPHIBIAN SCOUT CAR

376-3

Δ_s = 4,000 lbs.

GL = 4.08 feet aft of front axle

SPEED NO.		SPEED M.p.h.	RESISTANCE	E H P
			376-3a	
		(Corner off back of front wheel housing)		
H_1	8	7.70	859.2	17.6
			376-3b	
		(Same as above with sides of bow extension chamferred)		
H_1	8	7.70	823.6	16.9
			376-3c	
		(Same as above with part of stern cut off directly behind rear wheels)		
H_1	8	7.70	788.6	15.8
			376-3d	
		(Same as above with cover over rear wheel trunk)		
H_1	6	6.61	416.7	7.3
	8	7.70	743.6	15.3
	10	8.78	1192.0	27.9
			376-3e*	
H_1	8	7.70	732.3	15.0

Roughness addition - 0.400×10^{-3}.

*376-3e has sides of bow extension chamferred, part of stern cut off directly behind the rear wheels, cover over rear wheel trunk, but does not have corner off back of front wheel housing.

EXPERIMENTAL TOWING TANK
Stevens Institute of Technology
Hoboken, New Jersey

Sparkman & Stephens, Inc.

September 18, 1941
(Replaces Calc. IV report
of August 22)

AMPHIBIAN SCOUT CAR

376-4
Δ_s = 4,000 lbs.
G_1 = 4.08 feet aft of front axle
(Bow extended, 37-1/2° slope, corners chamferred, curved cutout aft of front wheel housing)

SPEED NO.		SPEED M.p.h.	RESISTANCE	E H P
H_1	7	7.156	497.7	9.5
	8	7.699	644.2	13.6
	9	8.241	906.1	19.9
	10	8.783	1153.0	27.0

376-4b

(Same as above with curved cutouts aft of front wheel housing put back)

H_1	8	7.699	6632.0	14.0

Roughness addition - 0.400×10^{-3}.

EXPERIMENTAL TOWING TANK
Stevens Institute of Technology
Hoboken, New Jersey

Sparkman & Stephens, Inc.

September 18, 1941
(Replaces Calc. V report
of August 25)

AMPHIBIAN SCOUT CAR

376-5

$-_S$ = 4,000 lbs.

G_L = 4.08 feet aft of front axle

(37-1/2° bow, corners rounded, curved cutouts
aft of front wheel housing)

SPEED NO.	SPEED M.p.h.	RESISTANCE	E H P
H_1 8	7.699	699.7	14.4

Roughness addition - 0.4000×10^{-3}.

EXPERIMENTAL TOWING TANK
Stevens Institute of Technology
Hoboken, New Jersey

Sparkman & Stephens, Inc.

September 18, 1941
(Replaces Calc. VI report
of September 15)

AMPHIBIAN SCOUT CAR

376-6

$-s$ = 4,000 lbs.

G_L = 4.08 feet aft of front axle

(37-1/2° bow, corners chamferred, curved cutout aft of front wheel housing, stern cut off)

SPEED NO.		SPEED M.p.h.	RESISTANCE	E H P
H_1	8	7.699	833.7	17.1

Roughness addition = 0.400 x 10^{-3}.

EXPERIMENTAL TOWING TANK
Stevens Institute of Technology
Hoboken, New Jersey

Sparkman & Stephens, Inc.

September 18, 1941
(Replaces Calc. VII report
of September 15)

AMPHIBIAN SCOUT CAR

376B-1

Δ_S = 4,000 lbs.

G_L = 4.08 feet aft of front axle

(Original floats - S. & S. 402-2A - mounted 3" away from the sides of the car, and 8-3/4" forward of original front of the car)

SPEED NO.	SPEED M.p.h.	RESISTANCE	E H P
R_1 8	7.699	851.2	17.5

Roughness addition - 0.400×10^{-3}

#402 (19) CALCULATION VII
9/24/41

EXPERIMENTAL TOWING TANK
Stevens Institute of Technology
Hoboken, New Jersey

Sparkman & Stephens, Inc. September 15, 1941

AMPHIBIAN SCOUT CAR

376C-1

$-s$ = 3,400 lbs.

G_L = 4.08 feet aft of front axle

(Second design floats mounted 3" away from the sides of the car with the deck of the floats 30" below the car deck. The longitudinal position of the floats corresponds to the drawing S. & S. 402-2B blue lines)

SPEED NO.		SPEED m.p.h.	RESISTANCE	E.H.P.
		All wheels in lowered position		
H_1	8	7.699	709	14.6
		Forward wheels in raised position After wheels in lowered position		
H_1	8	7.699	659	13.5
H_1	12	9.880	815	21.5

Roughness addition = 0.400×10^{-3}

CALCULATION VIII

#402 (20) 9/24/41

EXPERIMENTAL TOWING TANK
Stevens Institute of Technology
Hoboken, New Jersey

Sparkman & Stephens, Inc. September 15, 1941

AMPHIBIAN SCOUT CAR

376C-2

Δ_s = 3,400 lbs.

Δ_s = 4,000 lbs.

G_L = 4.08 feet aft of front axle

(The second design floats modified so as to have a 2.5" radius all along the chine. The floats were faired aft to eliminate a flat spot. The floats are mounted flush with the sides of the car, with the deck of the floats 30" below the car deck. Longitudinal position as indicated on S. & S. drawing.)

SPEED NO.		SPEED m.p.h.	RESISTANCE	E.H.P.
		Δ_s = 3,400 lbs.		
H_1	6	6.607	405	7.1
	7	7.156	585	11.2
	8	7.699	687	14.1
	9	8.241	724	15.9
	10	8.783	777	18.2
	11	9.335	827	20.6
	12	9.880	884	23.3
	13	10.43	947	26.3
	14	10.97	1023	30.0
		Δ_s = 4,000 lbs.		
H1	6	6.607	487	8.6
	7	7.156	702	13.4
	8	7.699	870	17.9
	9	8.241	977	21.5
	10	8.783	1066	25.0
	11	9.335	1130	28.1
	12	9.880	1189	31.3
	13	10.43	1247	34.7
	14	10.97	1317	38.5

Roughness addition = 0.400×10^{-3}

NOTE: All wheels in raised position.

CALCULATION IX

EXPERIMENTAL TOWING TANK
Stevens Institute of Technology
Hoboken, New Jersey

Sparkman & Stephens, Inc. September 18, 1941

AMPHIBIAN SCOUT CAR
376-4

$-_s$ variable (see below)

G_I = 4.08 feet aft of front axle

(Bow extended, 37 1/2° slope, corners chamferred, curved cutout aft of front wheel housing.)

All wheels in raised position.

SPEED NO.		SPEED m.p.h.	RESISTANCE	E.H.P.
		$-_s$ = 3,400 lbs.		
H_1	6	6.607	348	6.1
	7	7.156	454	8.7
	8	7.699	626	12.9
	9	8.241	836	18.4
	10	8.783	1042	24.4
	12	9.880	1298	34.2
		$-_s$ = 3,700 lbs.		
H_1	7	7.156	479	9.1
	8	7.699	658	13.5
	9	8.241	878	19.0
		$-_s$ = 4,000 lbs.		
H_1	6	6.607	383	6.7
	7	7.156	488	9.3
	8	7.699	664	13.6
	9	8.241	874	19.2
	10	8.783	1126	26.4
	12	9.880	1391	36.7

Roughness addition = 0.400×10^{-3}

NOTE: At 7.7 M.P.H. bow wave 7/8" below deck at center line and 1-1/2" below deck at corners of bow.

CALCULATION X

EXPERIMENTAL TOWING TANK
Stevens Institute of Technology
Hoboken, New Jersey

Sparkman & Stephens, Inc.

September 18, 1941

AMPHIBIAN SCOUT CAR

376-4

$-_s$ variable (see below)

G_L = 4.08 feet aft of front axle

(Bow extended, 37 1/2° slope, corners chamferred, curved cutout aft of front wheel housing.)

All wheels in lowered position

SPEED NO.		SPEED m.p.h.	RESISTANCE	E.H.P.
			$-_s$ = 3,400 lbs.	
H_1	6	6.607	413	7.3
	7	7.156	535	10.0
	8	7.699	668	13.7
	9	8.241	856	18.8
	10	8.783	1081	25.3
	12	9.880	1331	35.1
			$-_s$ = 4,000 lbs.	
H_1	6	6.607	423	7.5
	7	7.156	535	10.2
	8	7.699	696	14.3
	9	8.241	907	19.9
	10	8.783	1154	27.0
	12	9.880	1373	36.2

Roughness addition = 0.400×10^{-3}

CALCULATION Xa

9/24/41

#402

EXPERIMENTAL TOWING TANK
Stevens Institute of Technology
Hoboken, New Jersey

Sparkman & Stephens, Inc. September 22, 1941

AMPHIBIAN SCOUT CAR

376-4c

$-_s$ = 4,000 lbs.

G_L = 4.08 feet aft of front axle

(Bow extended, 37-1/2° slope, corners chamferred; curved cutout aft of front wheel housing; part of stern directly behind the rear wheels cut off -- triangular in form)

All wheels in raised position.

SPEED NO.	SPEED m.p.h.	RESISTANCE	E H P
H_1 7	7.156	491	9.4
8	7.699	664	13.6
9	8.241	894	19.6

Roughness addition - 0.400×10^{-3}

EXPERIMENTAL TOWING TANK
Stevens Institute of Technology
Hoboken, New Jersey

Sparkman & Stephens, Inc. September 24, 1941

AMPHIBIAN SCOUT CAR

376-4

Δ = 4,000 lbs.

Wheels up

Trim Measurements

Under the above conditions, the car floats at zero speed with the extreme bow 1.63 feet above water level and the extreme stern .70 feet above water level.

During a run made at Speed No. H_1 8 which is equivalent to 7.699 miles per hour, the bow rose .10 feet and the stern dropped .56 feet. Under these conditions the bow wave was .36 feet below the deck at the center of the bow and .63 feet below the deck at the sides of the bow.

EFFECT OF ALTERATIONS AT
7.7 M.P.H. and 4000# DISP.

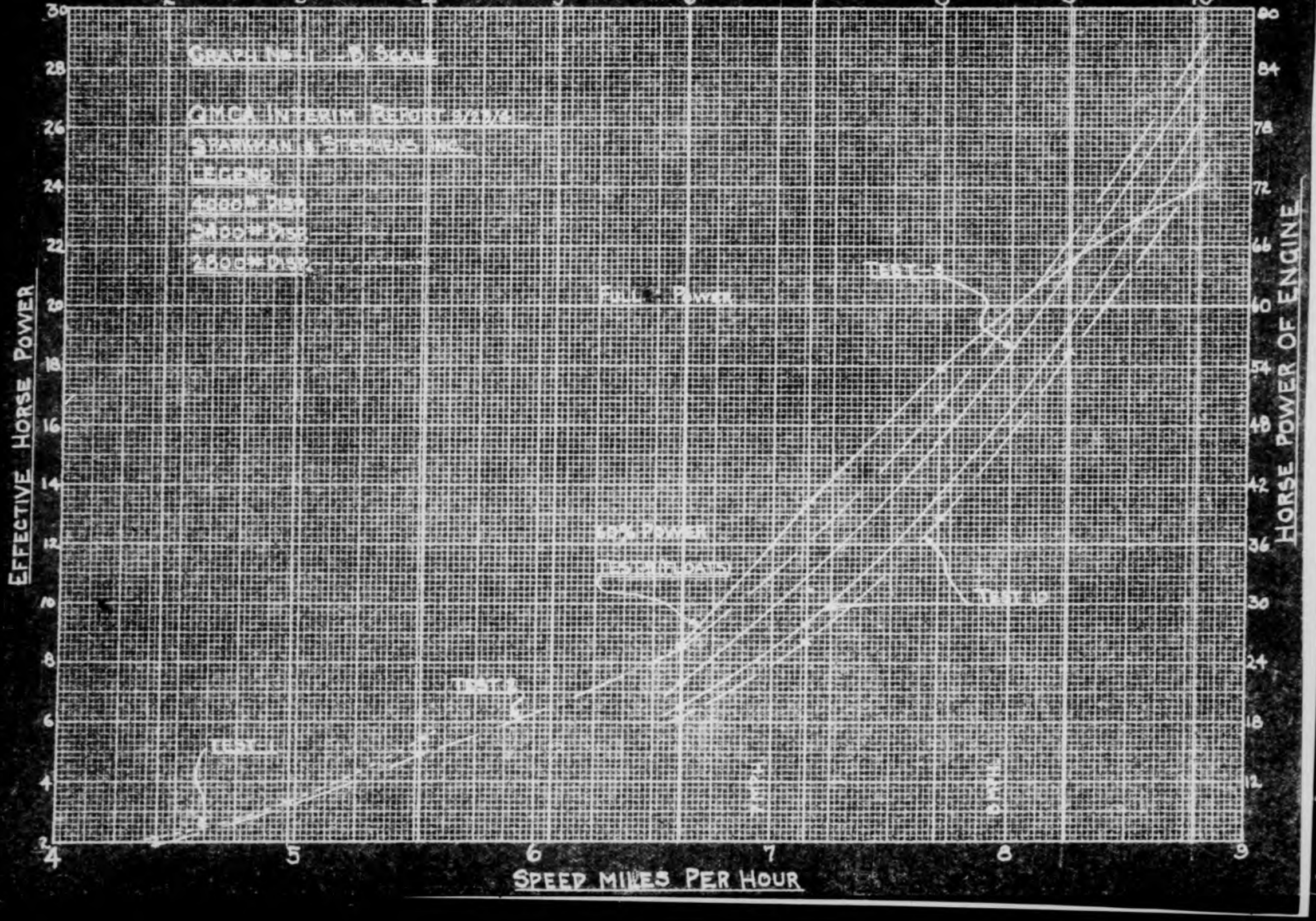
E.H.P.	Description of Alteration
17.2	Original model with alterations 1 & 2 - p. 5
<u>17.6</u>	Alteration 3 (cutout behind front wheel trunks) p. 6
16.9	Alteration 4(Bow corners chamferred) p. 6
15.8	Alteration 5 (Cutout behind rear wheel trunks) p. 6
15.3	Alteration 6 (Cover plate over rear wheels) p. 6
15.0	Alteration 3 eliminated - p. 6
14.0	Alteration 7 (flatter bow angle) p. 7
13.6	Alteration 8 (Revised cutout behind front wheel trunks) p.7
<u>14.4</u>	Alteration 9 (Bow corners rounded instead of chamferred) p. 8
<u>17.1</u>	Alteration 10 (Stern shortened 12" full scale) p. 8
13.6	Alteration & shape of cutout behind rear wheels - p. 11
<u>14.3</u>	Best model (as alteration 8) with wheels lowered - p. 10

<u>17.9</u> Floats - Test 9 - p. 9

<u>NOTE</u>: Where resistance increases, E.H.P. figures are underlined

KEUFFEL & ESSER CO., N.Y. NO. 389-11
20 × 20 to the Inch

GRAPH-1 STEVENS INST.- SPEED NUMBERS



GRAPH No.-2

STEVENS INST. SPEED NUMBERS

GRAPH-2 - A SCALE

QM CA INTERIM REPORT 9/25/41

SPARKMAN & STEPHENS INC.

LEGEND

4-BLADE PROP.

3-BLADE PROP.

FLOAT 6 TEST-9

FULL POWER

60% POWER

TEST-10

TEST-2

TEST-3

EFFECTIVE HORSE POWER

HORSE POWER OF ENGINE

M.P.H. - WATER SPEED

KEUFFEL & ESSER CO., N.Y. NO. 358-11
20 X 20 to the inch.

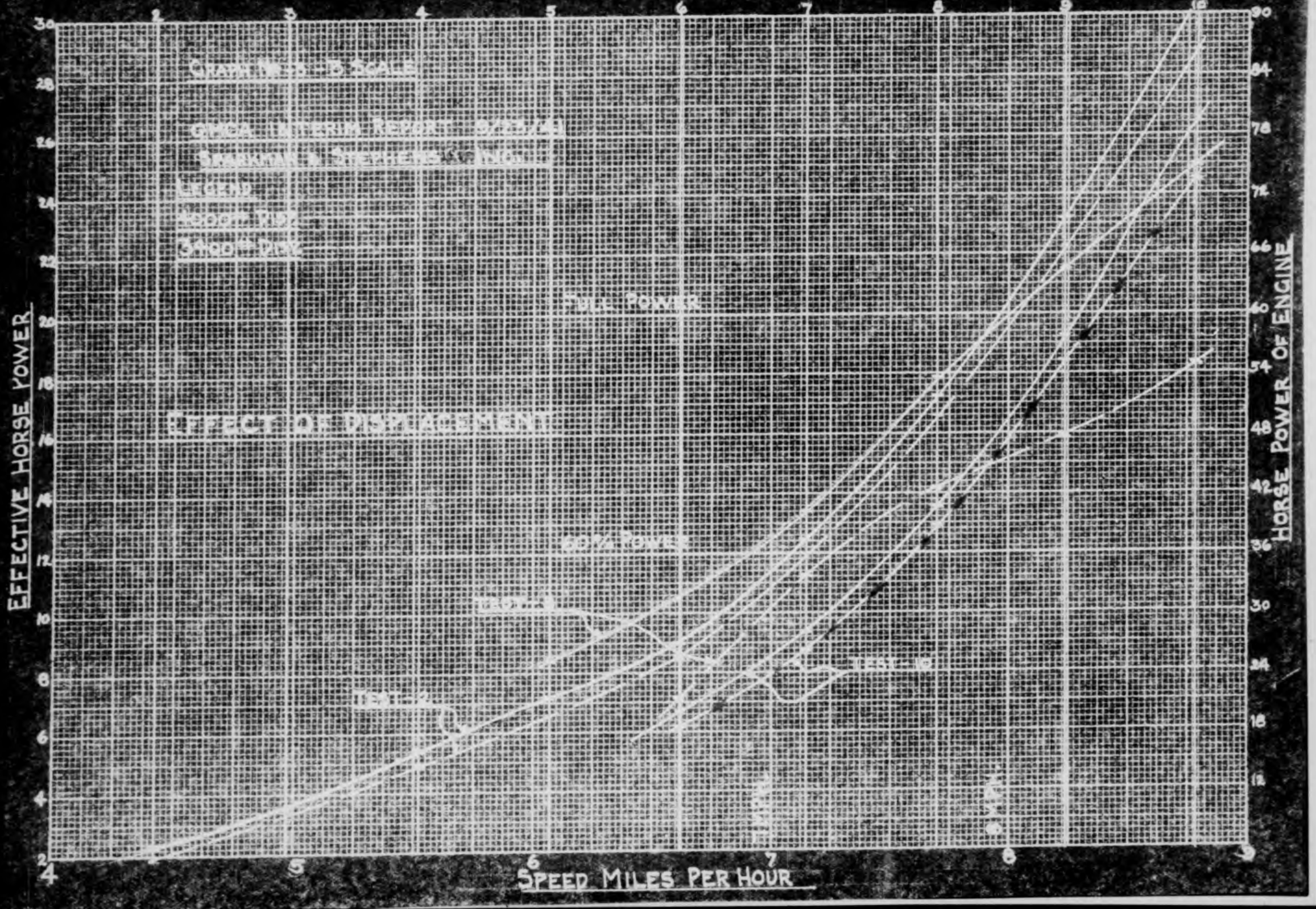
KEUFFEL & ESSER CO., N. Y. NO. 369-11
20 x 20 to the Inch.

GRAPH-3 STEVENS INST. - SPEED NUMBERS

EFFECTIVE HORSE POWER

POWER OF ENGINE HORSE POWER

SPEED MILES PER HOUR



KEUFFEL & ESSER CO., N. Y. NO. 364-11
20 × 20 to the inch.

GRAPH-4

STEVENS INST. — SPEED NUMBERS

GRADING — A & SAME

GMCA INTERIM REPORT 9/28/61

SPARKMAN & STEPHENS INC.

LEGEND

NOTES

TEST 10 WHEELS AFT

TEST 10A WHEELS FWD

FULL POWER

GMC POWER

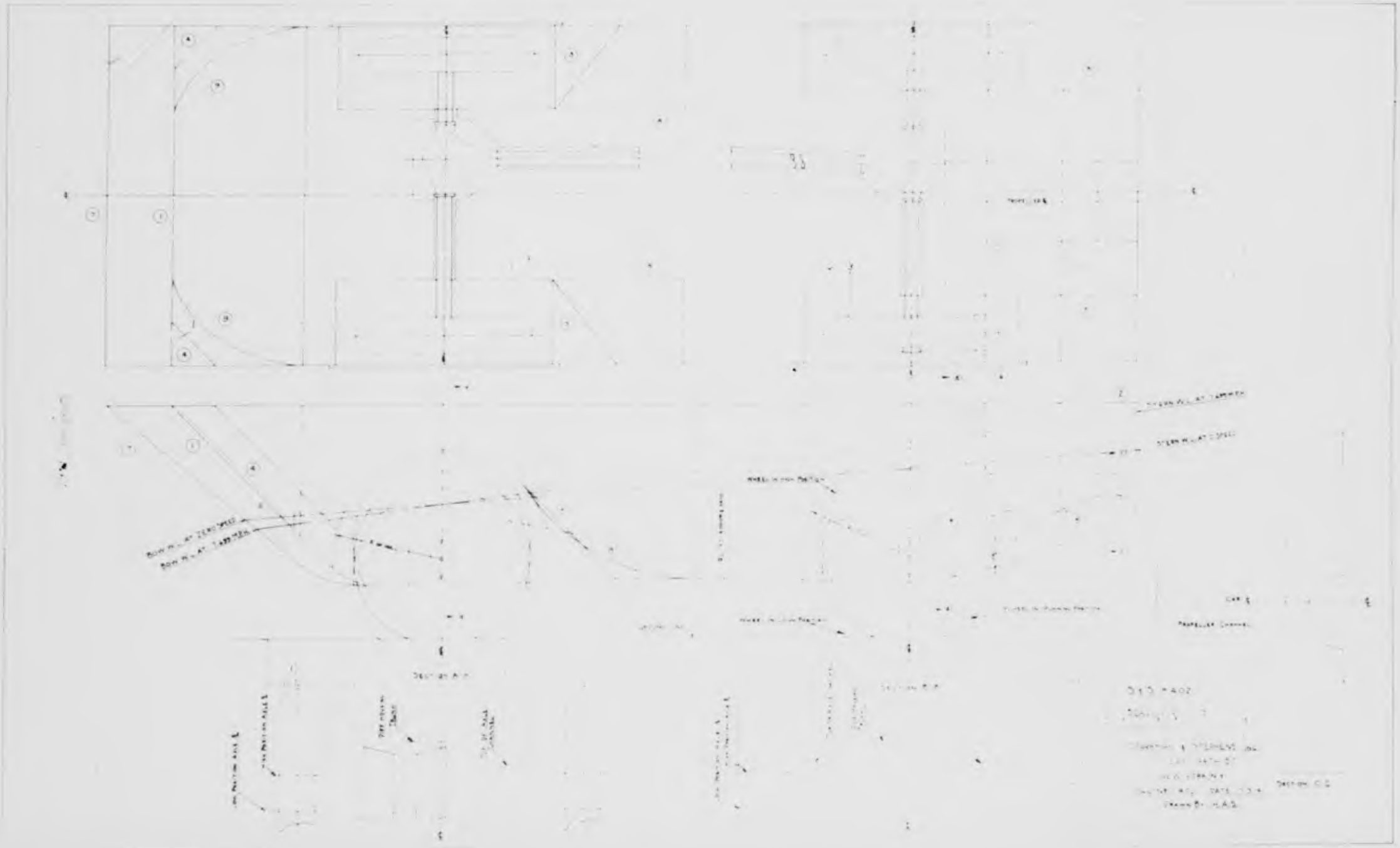
TEST 10A

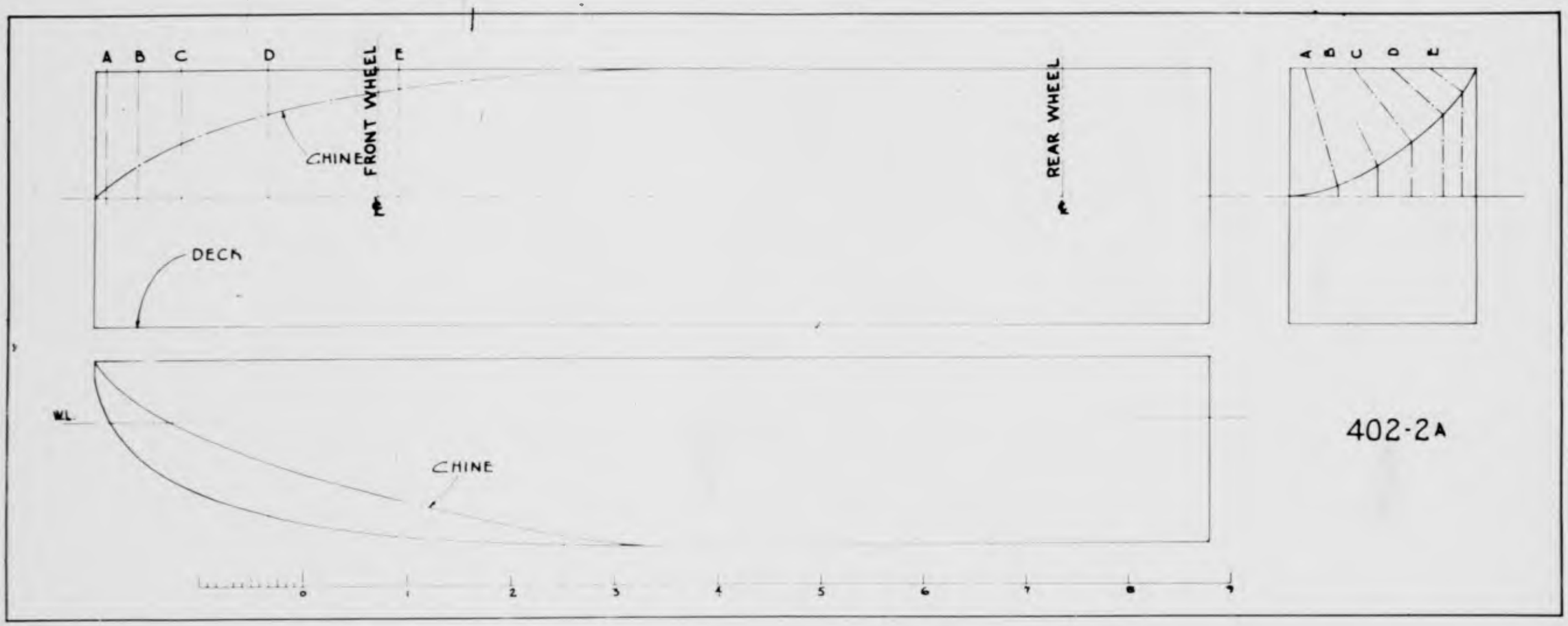
TEST 10

EFFECTIVE HORSE POWER

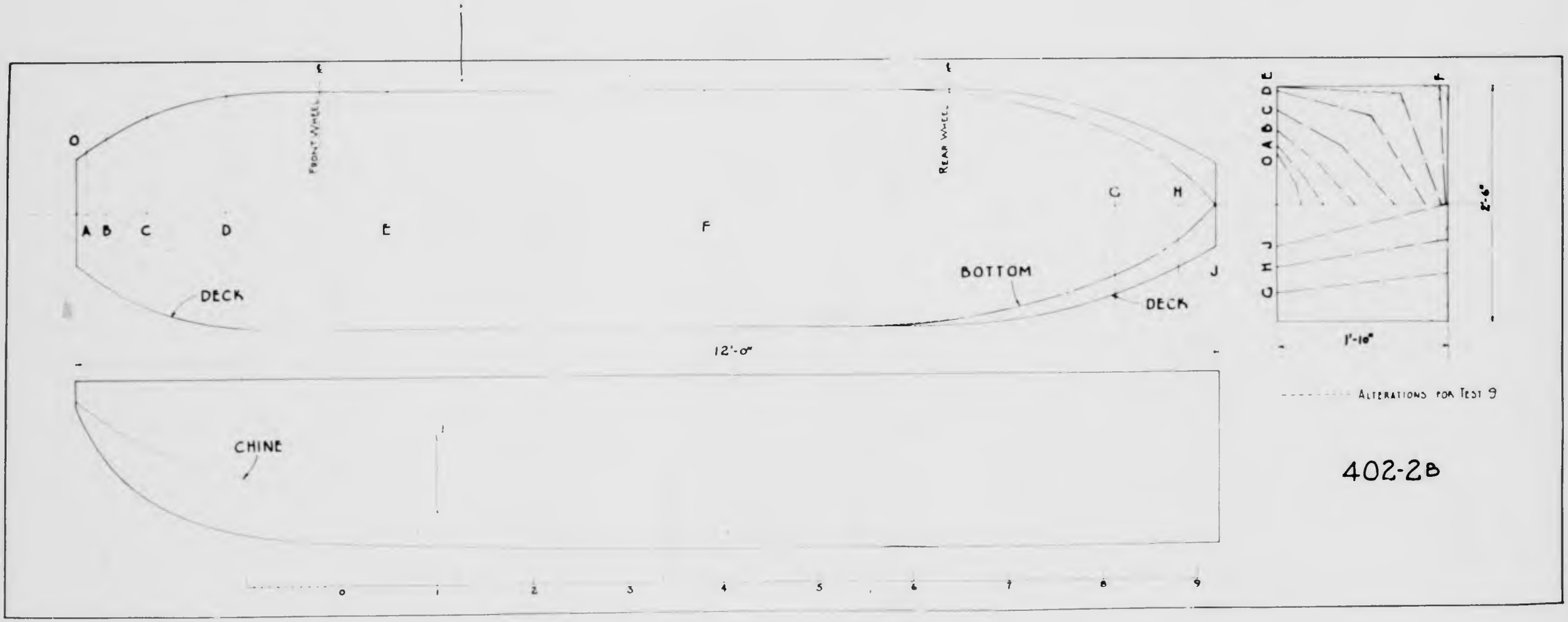
HORSE POWER OF ENGINE

SPEED MILES PER HOUR




A B C D E
FRONT WHEEL
CHINE
DECK
REAR WHEEL
A B C D E
WL
CHINE
0 1 2 3 4 5 6 7 8 9

402-2A


O
A B C D E F
FRONT WHEEL
REAR WHEEL
C H
DECK
BOTTOM
DECK
J
12'-0"
CHINE
0 1 2 3 4 5 6 7 8 9
O A B C D E
H J
E
D
1'-10"
2'-9"
ALTERATIONS FOR TEST 9

402-2B